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Title Page

Psychological Distress and Trauma in Doctors Providing Frontline Care During the COVID-19 Pandemic in the United Kingdom and Ireland: A Prospective Longitudinal Survey Cohort Study

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Objectives

The psychological impact of the COVID-19 pandemic on doctors is a significant concern. Due to the emergence of multiple pandemic waves, longitudinal data on the impact of COVID-19 is vital to ensure an adequate psychological care response. The primary aim was to assess the prevalence and degree of psychological distress and trauma in frontline doctors during the acceleration, peak and deceleration of the COVID-19 first wave. Personal and professional factors associated with psychological distress are also reported.

Design

A prospective online three-part longitudinal survey.

Setting

Acute hospitals in the UK and Ireland.

Participants

Frontline doctors working in Emergency Medicine (EM), Anaesthetics and Intensive Care Medicine (ICM) during the first wave of the COVID-19 pandemic in March 2020.

Primary outcome measures

Psychological distress and trauma measured using the General Health Questionnaire-12 and the Impact of Events-Revised.

Results

The initial acceleration survey distributed across networks generated a sample of 5440 doctors. Peak and deceleration response rates from the original sample were 71·6% (n=3896) and 56·6% (n=3079) respectively. Prevalence of psychological distress was 44·7% (n=1334) during the acceleration, 36·9% (n=1098) at peak and 31·5% (n=918) at the deceleration phase. The prevalence of trauma was 23·7% (n=647) at peak and 17·7% (n=484) at deceleration. The prevalence of probable post-traumatic stress disorder was 12·6% (n=343) at peak and 10·1% (n=276) at deceleration. Worry of family infection due to clinical work was the factor most strongly associated with both distress (R^2 = 0·06) and trauma (R^2 =0·10).

Conclusion

Findings reflect a pattern of elevated distress at acceleration and peak, with some natural recovery. It is essential that policymakers seek to prevent future adverse effects through (a) provision of vital equipment to mitigate physical and psychological harm (b) increased awareness and recognition of signs of psychological distress and (c) the development of clear pathways to effective psychological care.

Trial Registration: ISRCTN 10666798

Strength and limitations of this study

- This paper presents key findings from a large cross-sectional longitudinal survey of practising emergency, anaesthetic and intensive care doctors in UK and Ireland during the acceleration, peak and deceleration of the first wave of the COVID-19 pandemic.
- This study provides an insight into the associated personal and professional factors associated with trauma and distress and could be utilised to identify those doctors who will most benefit from psychological interventions.
- Variation in regional peaks may have influenced accurate capturing of psychological distress and trauma rates and have not been accounted for.
- The findings cannot be extrapolated to longer-term psychological impact, and future work is planned to capture this.

Introduction

Clinicians providing frontline care have become central to the primary reception, assessment, and ongoing hospital treatment of patients with suspected Coronavirus Infectious Disease 2019 (COVID-19). These include doctors working in Emergency Medicine (EM), Anaesthetics and Intensive Care Medicine (ICM). Whilst this healthcare workforce is highly resilient and accustomed to facing traumatic situations, the COVID-19 pandemic has imposed unprecedented demands in workload intensity and personal health risk. [1–4] High infection rates have been reported in frontline clinicians, with over 150 fatalities in the UK by May 2020. [5] These factors are likely to affect psychological wellbeing, increasing the risk of traumatic stress both in the acute phase of the pandemic and at long-term follow up. [6–9] Exposure to infectious disease outbreaks and elevated psychological distress have previously been associated with increased sickness rates, absenteeism, impaired performance at work, and the development of physical health problems. [10–12] There is also an emerging evidence base from around the world of the psychological impact on healthcare workers. [13–16] During the current COVID-19 pandemic there has been a global media focus on health and care workers with widespread public support. [17] However, there is increasing recognition amongst key opinion leaders and psychological societies that this pandemic will lead to an unparalleled, though as yet unquantified, impact upon the psychological wellbeing of healthcare workers. [18,19]

Studies evaluating psychological wellbeing in frontline clinicians during infectious disease outbreaks (including COVID-19) have demonstrated negative impacts may be significant. [10,20,21] Systematic reviews and meta-analyses converge around common predictors of psychological distress following traumatic events, many of which are relevant to frontline clinicians. Key factors include preparedness, training, social and occupational support, exposure and threat to life, media use and history of mental health problems. [1,7,21–23] However, these data have largely been collected as a snapshot either during or following outbreaks or as cross-sectional surveys in highly selected or self-selecting cohorts. Longitudinal data which describe evolving and cumulative effects on the psychological wellbeing of frontline working during the COVID-19 pandemic are therefore urgently required. Such studies are essential to understand and mitigate psychological impacts of future events upon this vital workforce and inform the development of policy and interventions.

The primary aim of this study was to assess the prevalence and degree of psychological distress and trauma in doctors providing frontline care during the acceleration, peak and deceleration phases of the COVID-19 pandemic. We also sought to establish which personal and professional factors were significantly associated with psychological distress at these time points.

Methods

Study Design and Participants

The "COVID-19 Emergency Response Assessment (CERA) Study" was a prospective online longitudinal survey of frontline doctors across the UK and Ireland undertaken during the acceleration, peak and deceleration phases of the first COVID-19 pandemic wave.[24] Doctors of all grades working in EM, Anaesthetics or ICM during the acceleration phase were invited to participate.

Procedures

This survey study is reported in line with Checklist for Reporting Results of Internet E-surveys (CHERRIES) guidelines. [25] Full details of survey distribution, design, administration, and time-points are available in the published protocol. [24] In brief, the survey was initially distributed during the acceleration phase of the first pandemic wave through research networks, training faculties or Royal College Networks via email or instant messaging groups, coordinated by identified site/region leads. The participation link was not shared on wider social media platforms, to avoid international contamination. At completion of the acceleration phase survey, participants entered personal email addresses for direct approach at peak and deceleration phases with a unique survey link to avoid duplication. The study was registered at the ISRCTN (10666798).

The acceleration, peak and deceleration surveys were developed iteratively by the study team and underpinned by evidence, or by consensus where necessary. Psychometric tools were selected by consensus of the study team, considering validity and utility of a range of standardised measures, balanced against the feasibility of delivery and completion by individuals likely to be working at maximum capacity.

Study data were collected and managed using REDCap (Research Electronic Data Capture) hosted at University Hospitals Bristol and Weston NHS Foundation Trust.[26,27] Acceleration, peak and deceleration phases were defined a priori and adapted from the United States Centre for Disease Control "Preparedness and Response Frameworks for Influenza Pandemics". [28] For each survey, exact survey distribution dates were decided per protocol by team consensus according to available public health data on number of confirmed cases (acceleration phase; UK: 18/03/2020 – 26/03/2020, Ireland: 25/03/2020 – 02/04/2020), nationally available COVID-19 daily death rates (peak phase; UK: 21/04/2020 – 05/05/2020, Ireland: 28/04/2020 – 12/05/2020) and at 30 days after distribution of the peak phase survey (deceleration phase; UK: 03/06/2020 – 17/06/2020, Ireland: 10/06/2020 – 24/06/2020). Ethical approval was obtained from the University of Bath (UK) and Children's Health Ethics Committee (Ireland). Regulatory approval was obtained from the Health Regulation Authority (UK), Health and Care Research Wales. Participants provided electronic informed consent for each survey.

Survey Questions

Survey questions collected data for both the primary and secondary outcomes. Items included the General Health Questionnaire-12 (GHQ-12; provided with licence fee waived by GL Assessments, London, UK) for distress, and the Impact of Events Scale- Revised (IES-R; off licence) for trauma. Personal and professional characteristics relating to participants' current role, and their preparedness and experiences during the pandemic were collected. These were used as secondary outcome measures and are provided in full in the protocol and online supplement. [24]

Outcomes

There were two co-primary outcomes in this survey: psychological distress, and trauma, as defined by the GHQ-12 and the IES-R respectively.

Distress – GHQ-12

The GHQ-12 is a 12-item self-report measure devised to screen for psychological distress in the general population. [29] The measure has high specificity and sensitivity, with reliability demonstrated across a range of populations. [30,31] The GHQ-12 has been used in similar clinician-based studies measuring the psychological impact of infectious outbreaks and was chosen due to the brevity of the measure and its suitability for time-pressured medical staff. [21] The GHQ-12 assesses current state and asks the participants to compare to usual state. GHQ-12 was asked at all 3 survey phases. Case level distress is defined as a score of more than 3. [30]

Trauma – IES-R

The IES-R is a 22-item measure commonly used to measure post-traumatic stress following a pre-specified traumatic incident and has been used to evaluate the impact of infectious disease outbreaks on hospital staff. [21,32] It contains 8 items that focus on 'intrusion', 8 items on 'avoidance' and 6 items on 'hyperarousal'. The IES-R was used at the peak and deceleration survey phases. A score of 24 or above indicates a clinically significant traumatic stress response, a score above 33 indicates best cut-off for a diagnosis of 'probable post-traumatic stress disorder' (PTSD). [33,34]

The secondary outcomes captured included personal and professional characteristics and their association with psychological distress and trauma. These personal and professional factors were identified through rapid literature review of high-quality systematic reviews and meta-analysis by experts in pandemic research. [1,21–23] All factors identified as predictors of outcome were retained. This was supplemented by factors deemed of specific or emerging interest by the expert study steering committee. These were defined a priori in the study protocol, with the exception of ethnicity which was added during the peak survey due to the specific emergence of ethnicity as a potential marker of poor physical health outcomes. [24]

Statistical Analysis

The statistical analysis is described in detail in the published protocol. [24] GHQ-12 items were reported using two methods. In the first method, item responses are assigned to the values 0, 0, 1, 1 (from the

most positive to the most negative sentiment) and summed to form an aggregate score from zero (least distressed) to 12 (most distressed). Using this method, a score of more than 3 is indicative of case-level distress. [30] The second method assigns responses to 0, 1, 2, 3 (positive to negative sentiment) producing a score in the range 0 to 36, with zero representing the most healthy response (no psychological distress) and 36 the most unhealthy (maximal psychological distress). By presenting the two different scoring methods, we can both report the prevalence of case level distress across the sample (0-0-1-1 scoring method) and more sensitively detect changes within the sample over the three phases of the pandemic (0-1-2-3 scoring method).

IES-R responses were analysed by assigning the responses to 0, 1, 2, 3, 4 (positive to negative) producing a score in the range 0 (no trauma) to 88 (maximal trauma). A score of 24 or above indicates a clinically significant traumatic stress response, a score above 33 indicates best cut-off for a diagnosis of 'probable post-traumatic stress disorder' (PTSD). [33,34]

The change over time in the GHQ-12 (phases 1, 2, and 3) and IES-R scores (phases 2 and 3) amongst participants who responded to all three surveys was examined with repeated measures linear mixed-effect models, with survey phase as the single fixed effect and a participant-level random effect. These model describe the association between pandemic phase and psychological distress (GHQ-12) and trauma (IES-R).

To identify potential modifiers of the change in GHQ-12-score or IES-R-score over time, further models were constructed for each of the measured personal and professional variables. Each model included the single variable of interest, survey phase, their interaction (to allow for a change in the association between the outcome and the variable over time), and a participant-level random effect as before.. Responses where the variable value was missing were removed. [35] Nagakawa's marginal R^2 was used to measure the proportion of outcome variance accounted for by the model (excluding random-effects, i.e., when there is no a-priori knowledge of the expected outcome for each participant). Values vary from 0 to 1, with 1 occurring when the model perfectly predicts the outcome, and 0 occurring when the model only returns the population average.

Finally, a comparison analysis done to compare distress and trauma outcomes in those who completed all 3 surveys against those who dropped out.

Software

All analyses and statistical outputs were produced in the statistical programming language R and the 'tidyverse', 'lme4' and 'ggeffects' packages were used for the mixed-effects models.[36–38]

Patient and Public Involvement

The study team contains frontline doctors from all represented specialties who undertook clinical work throughout the COVID-19 pandemic. This research is in line with recent RCEM research prioritisation and research recommendations. [39,40]

Role of the funding source

The sponsor and funder had no role at any stage of this work.

Results

Distribution across networks in the UK and Ireland generated 5440 responses. Follow-up responses from the peak and deceleration surveys were 3896 (71·6%) and 3079 (56·6%) respectively (figure 1). The final analysis cohort was 3079 participants, consisting of 1686 (54·8%) from EM, 1114 (36·2%) from Anaesthetics and 526 (17·1%) from ICM, with some participants working across multiple specialities.

The demographic and professional characteristics of the respondent population are summarised in Table 1. The cohort was 51·0% female, with a median age group of 36-40 years, and was representative of all professional grades. Respondents were 63·7% 'White British', 6·2% 'Irish', and '30·1% 'Ethnic Minority'; a full breakdown of ethnicity is provided in the online supplementary hub (https://github.com/wjchulme/TERN-CERA-study/tree/main/outputs). [41,42]

Table 1 Demographic and occupational characteristics of responders who completed all three study phases

	All (N=3079)	Emergency Medicine (N=1686)	Anaesthetics (N=1114)	Intensive Care Medicine (N=526)
Age				
20-25	111 (3·6%)	99 (5·9%)	3 (0·3%)	9 (1·7%)
26-30	737 (24·0%)	471 (28·0%)	184 (16·5%)	130 (24·8%)
31-35	682 (22·2%)	366 (21·7%)	242 (21·8%)	141 (26·9%)
36-40	497 (16·2%)	279 (16·6%)	177 (15·9%)	81 (15·5%)
41-45	406 (13·2%)	220 (13·1%)	156 (14·0%)	55 (10·5%)
46-50	282 (9·2%)	128 (7·6%)	133 (12·0%)	55 (10·5%)
51-55	203 (6·6%)	72 (4·3%)	121 (10·9%)	27 (5·2%)
56-60	107 (3·5%)	34 (2·0%)	63 (5·7%)	19 (3·6%)
>60	49 (1·6%)	14 (0·8%)	33 (3·0%)	7 (1·3%)
Missing	5	3	2	2
Gender				
Male	1455 (48·8%)	774 (47·4%)	542 (50·1%)	272 (53·8%)
Female	1522 (51·0%)	855 (52·4%)	538 (49·7%)	233 (46·0%)
Other	7 (0·2%)	4 (0·2%)	2 (0·2%)	1 (0·2%)
Missing	95	53	32	20
Seniority				
Junior Doctor	1089 (35·4%)	692 (41·0%)	276 (24·8%)	187 (35·6%)
Middle Grade Doctor	660 (21·4%)	357 (21·2%)	230 (20·6%)	129 (24·5%)
Other Senior Doctor	228 (7·4%)	156 (9·3%)	66 (5·9%)	34 (6·5%)
Senior Doctor (Consultant Grade)	1102 (35·8%)	481 (28·5%)	542 (48·7%)	176 (33·5%)
Geographical Region				
East Midlands	177 (5·7%)	78 (4·6%)	84 (7·5%)	24 (4·6%)
East of England	172 (5·6%)	87 (5·2%)	70 (6·3%)	29 (5·5%)
London	454 (14·7%)	319 (18·9%)	103 (9·2%)	42 (8·0%)
North East	132 (4·3%)	68 (4·0%)	47 (4·2%)	30 (5·7%)
North West	334 (10·8%)	149 (8·8%)	141 (12·7%)	78 (14·8%)
South East	355 (11·5%)	229 (13·6%)	105 (9·4%)	48 (9·1%)
South West	430 (14·0%)	208 (12·3%)	167 (15·0%)	76 (14·4%)
West Midlands	183 (5·9%)	89 (5·3%)	78 (7·0%)	44 (8·4%)
Yorkshire and the Humber	212 (6·9%)	90 (5·3%)	102 (9·2%)	55 (10·5%)
Northern Ireland	87 (2·8%)	41 (2·4%)	34 (3·1%)	20 (3·8%)
Scotland	253 (8·2%)	159 (9·4%)	80 (7·2%)	32 (6·1%)

Wales	92 (3·0%)	21 (1·2%)	62 (5·6%)	21 (4·0%)
Dublin	111 (3·6%)	82 (4·9%)	21 (1·9%)	16 (3·0%)
Rest of Ireland	87 (2·8%)	66 (3·9%)	20 (1·8%)	11 (2·1%)
Nation				
England	2449 (79·5%)	1317 (78·1%)	897 (80·5%)	426 (81·0%)
Northern Ireland	87 (2·8%)	41 (2·4%)	34 (3·1%)	20 (3·8%)
Republic of Ireland	198 (6·4%)	148 (8·8%)	41 (3·7%)	27 (5·1%)
Scotland	253 (8·2%)	159 (9·4%)	80 (7·2%)	32 (6·1%)
Wales	92 (3·0%)	21 (1·2%)	62 (5·6%)	21 (4·0%)
Ethnicity				
White British	1888 (63·7%)	949 (58·4%)	755 (70·3%)	338 (67·1%)
Irish	185 (6·2%)	118 (7·3%)	51 (4·7%)	33 (6·5%)
Ethnic minority	893 (30·1%)	557 (34·3%)	268 (25·0%)	133 (26·4%)
Missing	113	62	40	22
Redeployed				
Yes	249 (8·1%)	47 (2·8%)	196 (17·6%)	20 (3·8%)
No	2824 (91·9%)	1636 (97·2%)	916 (82·4%)	504 (96·2%)
Missing	6	3	2	2

Primary Outcomes

General Health Questionnaire-12

The prevalence of psychological distress, as defined by scores >3 on the GHQ-12 0-0-1-1 scoring method, was 44·7% (n=1334) in the acceleration survey, 36·9% (n=1098) at peak and 31·5% (n=918) during the deceleration phase. Median GHQ-12 scores were 13·0 (Q1-Q3, 10·0-17·0), 13·0 (Q1-Q3, 9·0-16·0) and 12·0 (Q1-Q3, 9·0-16·0) respectively (figure 2), and mean scores were 13·7, 13·2 and 12·9 across the acceleration, peak and deceleration surveys. Median distress scores were higher in the Anaesthetic and ICM cohorts at the acceleration phase when compared to EM, but these decreased in all three groups throughout the first pandemic wave.

Impact of Events Scale-Revised

The prevalence of psychological trauma, as defined by a score of >24 on the IES-R, was 23·7% (n=647) at peak and 17·7% (n=484) at deceleration. The prevalence of 'probable PTSD', as defined by a score of >33 was 12·6% (n=343) at peak and 10·1% (n=276) at deceleration. During the peak phase, prevalence of trauma (>24) was 24·9% (n=378) in EM, 21·5% (n=204) in anaesthetics and 24·9% (n=117) in ICM. Prevalence of 'probable PTSD' (>33) was higher in EM (13·9%, n=211) and ICM (13·6%, n= 64) when compared to Anaesthetics (10·8%, n=103). During the deceleration phase, prevalence of trauma (>24) decreased to 19·7% (n=93) in ICM and 18·7% (n=285) in EM. 'Probable PTSD' (>33) decreased to 11·1% (n=169) in EM, compared to 10·8% (n=51) in ICM and 8·8% (n=85) in Anaesthetics. The median IES-R was highest in the peak survey at 13 (Q1-Q3, 5-24), and 9 (Q1-Q3, 2-19) in the deceleration survey (see table 2 and figure 3).

Table 2. GHQ-12 and IES-R Scores for participants who responded to all 3 survey phases

	All (N=3079)	Emergency Medicine (N=1686)	Anaesthetics (N=1114)	Intensive Care Medicine (N=526)
Acceleration				

GHQ-12 (0123 score)				
Mean	13·7	13·3	14·4	14·0
Median (Q1, Q3)	13·0 (10·0, 17·0)	13·0 (10·0, 16·0)	14·0 (11·0, 18·0)	14·0 (10·2, 17·0)
GHQ-12 (0011 > 3)				
> 3	1334 (44·7%)	667 (40·7%)	542 (50·2%)	253 (49·6%)
N-Missing	92	48	34	16
Peak				
GHQ-12 (0123 score)				
Mean	13·2	12·8	13·6	13·6
Median (Q1, Q3)	13·0 (9·0, 16·0)	12·0 (9·0, 16·0)	13·0 (10·0, 17·0)	13·0 (10·0, 17·0)
GHQ-12 (0011 > 3)				
> 3	1098 (36·9%)	543 (33·3%)	454 (42·3%)	211 (41·1%)
N-Missing	105	56	40	13
IES-R score				
Mean	16·3	16·7	15·8	17·2
Median (Q1, Q3)	13·0 (5·0, 24·0)	13·0 (5·0, 24·0)	13·0 (6·0, 23·0)	14·0 (6·0, 24·0)
IES-R > 24				
IES-R-0123 > 24	647 (23·7%)	378 (24·9%)	204 (21·5%)	117 (24·9%)
IES-R > 33				
IES-R-0123 > 33	343 (12·6%)	211 (13·9%)	103 (10·8%)	64 (13·6%)
N-Missing	349	165	163	57
Deceleration				
GHQ-12 (0123 score)				
Mean	12·9	12·8	13·0	13·1
Median (Q1, Q3)	12·0 (9·0, 16·0)	12·0 (9·0, 16·0)	12·0 (9·0, 16·0)	12·0 (9·0, 17·0)
GHQ-12 (0011 > 3)				
> 3	918 (31·5%)	486 (30·2%)	340 (32·6%)	172 (34·6%)
N-Missing	165	78	71	29
IES-R score				
Mean	13·2	13·6	12·6	14·2
Median (Q1, Q3)	9·0 (2·0, 19·0)	9·0 (2·0, 20·0)	8·0 (2·0, 18·0)	9·0 (3·0, 20·0)
IES-R > 24				
IES-R-0123 > 24	484 (17·7%)	285 (18·7%)	159 (16·5%)	93 (19·7%)
IES-R > 33				
IES-R-0123 > 33	276 (10·1%)	169 (11·1%)	85 (8·8%)	51 (10·8%)
N-Missing	344	164	153	53

Secondary Outcomes

Risk Factors for Psychological Distress (GHQ-12) and Trauma (IES-R)

The overall strength of the relationship between participant factors and the two outcome measures, psychological distress and trauma, is summarised using Nagakawa's marginal R^2 (figures 4+5). The form of these univariable relationships is described graphically for the five variables with the highest R^2 values in figures 6 a-f. Graphs for the remaining variables are reported in online supplementary hub (https://github.com/wjchulme/TERN-CERA-study/tree/main/outputs).

Personal and Professional variables predicting distress (GHQ-12)

Worry of infecting family members due to clinical work (R^2 = 0·06) and worry of personal infection (R^2 = 0·05) were the two variables most strongly associated with distress. Figures 6a and 6b report the mean

GHQ-12-score for the levels within this variable. Those that were 'extremely worried' about infecting family had a mean GHQ-12-modelled score of 15·3 (95% CI, 15·0, 15·6), 15·1 (95% CI,14·8, 15·5) and 14·6 (95% CI,14·3, 15·0) during the acceleration, peak and deceleration respectively, compared with mean scores of 13·7, 13·2 and 12·9 respectively for all participants. For those who were 'extremely worried' about personal infection, the mean GHQ-12 modelled score was 16·6 (95% CI, 16·1, 17·1) during the acceleration period, compared with 10·9 (95% CI, 9·7, 12·1) for those who were 'not worried at all' about being infected. For the mean GHQ-12 modelled score for each of the other variables see the online link for the figures and values (https://github.com/wjchulme/TERN-CERA-study/tree/main/outputs).

Personal and Professional variables predicting trauma (IES-R)

For trauma, worry of infection of family members due to clinical role had the highest R^2 value (R^2 =0·10). Mean IES-R modelled score for those who were 'extremely worried' about infecting family was 23·0 (95% CI, 22·2, 23·8) during the peak compared to 10·0 (95% CI, 7·8, 12·2) for those who were 'not worried at all' during the peak (Fig 6c). This is significantly higher than the reported mean IES-R overall of 16·3.

Concern that COVID-19 would exacerbate symptoms of an established mental health condition (R^2 = 0·06) had the second highest R^2 value. Peak IES-R mean modelled scores were 23·3 (95% CI, 22·1, 24·4) in those who agreed with this statement compared to 15·2 (95% CI, 14·7, 15·7) in those who disagreed. Deceleration mean IES-R modelled scores remained high for those who agreed, 22·3 (95% CI, 21·1, 23·6). (Figure 6d)

Worry relating to personal infection due to clinical role (R^2 = 0·06) was again strongly associated with trauma. Figure 6e displays the mean IES-R modelled scores and demonstrates the peak (24·0 (95% CI, 22·5, 25·4)) and deceleration (20·3 (95% CI, 18·7, 21·8)) outcomes in participants who were 'extremely worried' compared to those who were 'not worried at all' during the peak (11·3 (95% CI 8·6, 14·0)) and deceleration (10·0 (95% CI 8·0, 12·0)).

Whilst ethnicity was not strongly associated with distress, it was a stronger predictor of trauma (R^2 = 0·03). Mean modelled trauma scores for 'Ethnic Minority' participants at peak was 18·8 (95% CI, 17·8, 19·8), compared to 'White British' participants of 15·1 (95% CI, 14·5, 15·8). (Figure 6f) For the mean IES-R modelled scores for each of the other variables see online link for the figures and values. (https://github.com/wjchulme/TERN-CERA-study/tree/main/outputs)

Incidence of self-reported COVID-19 infection and isolation

By the deceleration phase of the pandemic 6·9% (n=212) of respondents had received a positive diagnosis of COVID-19 and 0·4% (n=12) had been admitted to hospital. A positive diagnosis did not have a significant effect in prediction of trauma (R^2=0·014).

Regional and national variation of psychological distress and trauma

The region in which participants worked was more valuable for predicting trauma (R^2 = 0·034), than for distress (R^2 = 0·016). The mean modelled score of the different regions within the UK and Republic of Ireland on IES-R is demonstrated in figure 7.

Drop-out by GHQ-12 and IES-R

Response rate for the peak and deceleration surveys was 71.6% and 56·6% respectively. There was no significant difference in either the GHQ-12 or IES-R scores between those who dropped out and those who remained in the study (see online supplement).

Discussion

In this prospective longitudinal survey of 3079 frontline doctors, the prevalence of psychological distress reached 44·7% during the acceleration phase, and reached 23·7% for trauma during the peak phase - these figures were substantially higher than for the general population. [43] For psychological distress, rates declined through peak and deceleration phases of the first wave to a level comparable to pre-pandemic levels. [44] Prevalence of 'probable PTSD' was 12·6% at peak and 10·1% at deceleration, demonstrating a degree of natural recovery. [45,46] However, just less than a quarter experienced sub-threshold post-trauma symptoms 30 days following the pandemic peak.

Personal factors were the most powerful predictors of both psychological distress and trauma. The most significant predictors relate to familial safety, personal safety, and established mental health conditions. These findings support aggregated data in recent reviews and meta-analyses on the key predictors of psychological distress in disaster or infectious outbreak settings. [1,7,21–23] However, it cannot be ignored that the psychological harm associated with both familial and personal safety may potentially be explained by the perceived (and reported) inadequate provision of PPE to frontline workers. [47,48] This is an area where improvements must be made in order to mitigate against future physical and psychological harms that novel pathogens present.

While most findings are consistent with existing research, our study also identifies ethnicity as a novel, key predictor of trauma. [49–51] This is unsurprising given higher rates of reported mortality in ethnic minority groups with this particular pandemic. [52] However the nature and direction of relationship between these risk factors and poorer outcomes is undoubtedly complex. Ongoing work continues to seek further understanding in this area. [53]

Rates of trauma were high across all three specialty groups. One in four doctors met the clinical threshold, with the highest rates seen in EM and ICM. This is likely explained by their clinical roles during the pandemic, in which they were exposed to a higher volume of COVID-19 positive patients compared to Anaesthetic colleagues. However, it is important to note that the rate of trauma seen in Anaesthetics was also of concern. At the deceleration phase, EM doctors had higher rates of 'probable PTSD' (IES-R >33), whereas ICM doctors had a higher prevalence of trauma (IES-R >24). This may

reflect the later peak in ICUs when compared to EM [54] or the potential impact of downstream mortality. Further work should explore longer term outcomes in all cohorts.

It is evident from our longitudinal data that vulnerability to poorer psychological outcomes may be predicted by certain characteristics and therefore potentially mitigated through targeted intervention. Studies examining psychiatric outcomes in SARS reflect that psychological distress is likely to persist. Identification of those likely to experience adversity, and interventions to mitigate these, must begin now. [8,10,55,56] Without appropriate support and intervention doctors are likely to experience long-term effects on mental health, resulting in increased sickness rates, absenteeism, impaired performance at work, and the development of physical health problems. [8,10,12,57,58] Therefore the early identification of ongoing psychological distress will be pivotal in influencing the longer-term mental health of frontline workers. Based on research from COVID-19 and other pandemics, we can be certain that rates and severity of distress will rise following this second wave of the pandemic. We now know that doctors are working on the frontline while carrying the heavy burden of fear of infecting themselves, or critically, family members, while some continue to battle high levels of psychological distress. This distress was evident in the lead up to the first peak, but sustained well beyond this time point. Doctors are continuing to work in very highly pressured, high risk environments with a significant proportion doing so despite clinical levels of distress. Policymakers and professional bodies should urgently seek to develop an overarching 'best practice' pathway to support all healthcare staff in these environments.

While various interventions are recommended specifically for frontline workers there is common agreement in the necessity for basic psychosocial interventions (i.e. sleep hygiene, exercise, health behaviour) to facilitate return to equilibrium [59–62], yet these measures are not always sufficient to ameliorate persistent distress. It is crucial that an overarching 'best practice' pathway and package of care is implemented to help support staff now and for the future. This must be evidence-based, multilevel, starting with the 'individual' level and moving though to 'organisational' level intervention, including (a) mobilisation of formal peer & organisational support structures, (b) mechanisms for recognising and monitoring distress, and (c) offer clear referral pathways to evidence-based interventions. Access to appropriate psychological support is imperative; cognitive behavioural therapy is recommended by the National Institute for health and Care Excellence (NICE) to ameliorate anxiety, depression and PTSD [63,64] however further work is needed to ensure these interventions this are suitably tailored to the practicalities of shift work and the unique experiences faced by frontline clinicians. With this, there is a responsibility to ensure equality in the provision of care and pathways to access, for this is likely to be necessary for many.

Strengths and Weaknesses

This is a large-scale longitudinal study examining prevalence of psychological distress in doctors in the UK and Ireland, offering a robust and reliable measure of the impact of COVID-19 on the mental health of frontline doctors, and allows comparison with other pandemic mental health trajectories. Due to the three-phase prospective design and extent of data collected, findings from this study can be reliably

used to inform the development of preparations and interventions to mitigate the impact of COVID-19 and future infectious disease outbreaks on mental health in frontline doctors.

However, there are limitations that may influence our findings. The reported rates of distress and trauma do not take account of any pre-existing psychiatric morbidity or historical factors that may predispose doctors to developing mental health difficulties in these circumstances. [40,65–67] Data was gathered with regards to historical trauma, one of the most significant predictors of mental health difficulties long-term. Furthermore, whilst the sample size is large, any self-reporting measure is open to selection bias. This may have resulted in a biased sample with particularly high or low levels of distress and trauma. However, in the follow-up surveys (peak and deceleration) there was no difference in acceleration distress or trauma scores between those who dropped out and those who continued; yet we are unable to comment on those who declined to participate. Whilst the two primary outcome measures, GHQ-12 and IES-R, have good psychometric properties, there is a concern that survey data may overstate the prevalence of cases when compared to formal diagnostic interviews such as the SCID (The Structured Clinical **Interview** for DSM-IV Axis I Disorders); this is difficult to implement in such large samples, thus we cautiously avoid inference of definite diagnosis.

While the protocol was closely adhered to, variation in regional peaks may have influenced accurate capturing of psychological distress and trauma rates. It is noted that whilst the acceleration phase is study 'baseline', as the pandemic was present and proliferating in the UK at the acceleration phase, it more accurately represents the initial stress associated with a rapidly spreading highly infectious virus of unknown pathogenic origins and no effective treatment; a reasonable response to the context. Future research should continue to follow frontline doctors through the pandemic and beyond, to assess whether the mental health trajectories are similar to other infectious disease pandemics.

Conclusion

Our findings reflect a pattern of elevated distress during the acceleration and peak phase of the current pandemic, some degree of natural recovery and a significant minority continuing to experience residual ongoing distress. It is essential that policymakers and professional bodies seek to prevent future adverse effects through provision of vital equipment to mitigate both physical and psychological harm and the development of clear pathways to effective psychological care. Moving forward, it is essential the COVID-19 pandemic serves as a foundation for significant development and growth in all of these areas and that there is ongoing assessment of the psychological health of healthcare workers both during the pandemic and beyond.

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The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. Tom Roberts (TR) conceived the idea for the study. TR, Edd Carlton (EC), Jo Daniels (JD), Mark Lyttle (ML), and Blair Graham (BG) were responsible for the initial study design, which was refined with the help of Katie Samuel (KS), Charles Reynard (CR), Robert Hirst (RH), Michael Barrett (MB) and William Hulme (WH). Expert advice on psychological assessment scores was provided by JD. WH provided the statistical plan. TR lead the dissemination of the study in UK Adult Emergency Departments (ED), ML lead the dissemination of the study in UK and Ireland Paediatric EDs, KS lead the dissemination of the study in UK Anaesthetic and ICU Departments, MB lead the dissemination of the study in Ireland EDs, along with John Cronin, James Foley and Etimbuk Umana. Joao Vinagre lead the dissemination in Ireland ICUs and Anaesthetic Departments. TR coordinated study set-up, finalisation of the study surveys and finalisations of study protocols. All authors contributed to the final study design and protocol development, critically revised successive drafts of the manuscript and approved the final version. The study management group is responsible for the conduct of the study.

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Competing interests
Many of the authors have been working as frontline clinicians during the COVID-19 pandemic. They have no competing interests to declare.

Data Sharing

Deidentified participant data will be made available for 2 years post publication. Requests for access will require HRA and ethical approval and decisions regarding data sharing will be made after discussion with the study senior authors. Statistical code and study figures are available directly from: https://github.com/wjchulme/TERN-CERA-study/tree/main/outputs.

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N	Marriage	Kingston Hospital, London
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S	Hart	Leeds General Infirmary
M	Elsheikh	Leeds General Infirmary
L	Cocker	Leicester Royal Infirmary
MH	Elwan	Leicester Royal Infirmary
K L	Vincent	Leicester Royal Infirmary
C	Nunn	Leicester Royal Infirmary
N	Sarja	Lister Hospital, Stevenage
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C	Rimmer	Southport Hospital, Merseyside
S	Pintus	Southport Hospital, Merseyside
H	Jarman	St George's Hospital, London
V	Worsnop	St George's Hospital, London
S	Collins	St Helier Hospital
M	Colmar	St John's Hospital, Livingston
N	Masood	St John's Hospital, Livingston
R	McLatchie	St John's Hospital, Livingston
A	Peasley	Stepping Hill Hospital
S	Rahman	Stoke Mandeville Hospital
N	Mullen	South Tyneside and Sunderland NHS Trust
L	Armstrong	The Royal Berkshire Hospital, Reading
A	Hay	The Whittington Hospital, London
R	Mills	The Whittington Hospital, London
J	Lowe	Torbay Hospital, Devon
H	Raybould	Torbay Hospital, Devon
A	Ali	Torbay Hospital, Devon
P	Cuthbert	Ulster Hospital Dundonald, N. Ireland
S	Taylor	University College London Hospital
V	Talwar	University College London Hospital
Z	Al-Janabi	University Hospital Ayr, Scotland
C	Leech	University Hospital Coventry
J	Turner	University Hospital Coventry
L	McKechnie	University Hospital Crosshouse, Scotland
B	Mallon	University Hospital Crosshouse, Scotland
J	McLaren	University Hospital Crosshouse, Scotland
Y	Moulds	University Hospital Crosshouse, Scotland
L	Dunlop	University Hospital Hairmyres, Scotland
FM	Burton	University Hospital Hairmyres, Scotland
S	Keers	University Hospital Lewisham, London
L	Robertson	University Hospital Lewisham, London
D	Craver	University Hospital Lewisham, London
N	Moultrie	University Hospital Monklands, Scotland
O	Williams	University Hospital of North Tees
S	Purvis	University Hospital of North Tees
M	Clark	University Hospital of North Tees
C	Davies	University Hospital of Wales, Cardiff
S	Foreman	University Hospital of Wales, Cardiff
C	Ngua	University Hospital of Wales, Cardiff
D	George	University Hospital of Wales, Cardiff

A	Da-Costa	Medway NHS Foundation Trust
S	Duckitt	Medway NHS Foundation Trust
J	Bailey	Milton Keynes University Hospital
L	How	Milton Keynes University Hospital
T	Hine	Milton Keynes University Hospital
F	Ihsan	Milton Keynes University Hospital
H	Abdullah	Milton Keynes University Hospital
K	Bader	Milton Keynes University Hospital
S	Pradhan	Milton Keynes University Hospital
M	Manoharan	Milton Keynes University Hospital
C	Battle	Morriston Hospital, Wales
L	Kehler	Wolverhampton NHS Trust
R	Muswell	Newham University Hospital, London
M	Bonsano	Newham University Hospital, London
J	Evans	Norfolk and Norwich Hospitals
E	Christmas	North Hampshire Hospital, Basingstoke
K	Knight	North Middlesex Hospital, London
L	O'Rourke	North Tees Hospital, Stockton on Tees
K	Adeboye	North Tees Hospital, Stockton on Tees
K	Iftikhar	Northern General Hospital, Sheffield
R	Evans	Northern General Hospital, Sheffield
R	Darke	Northumbria Specialist Emergency Hospital
R	Freeman	Northumbria Specialist Emergency Hospital
E	Grocholski	Northwick Park Hospital, London
K	Kaur	Peterborough City Hospital
H	Cooper	Peterborough City Hospital
M	Mohammad	Princess Royal Hospital, London
L	Harwood	Princess Royal Hospital, London
K	Lines	Queen Alexandra Hospital, Portsmouth
C	Thomas	Queen Alexandra Hospital, Portsmouth
D	Ranasinghe	Queen Alexandra Hospital, Portsmouth
S	Hall	Queen Elizabeth Hospital
J	Wright	Queen Elizabeth Hospital
S	Hall	Queen Elizabeth Hospital
N	Ali	Queen Elizabeth Hospital
J	Hunt	Queen Elizabeth Hospital, Birmingham
H	Ahmad	Queen Elizabeth Queen's Mother, Margate
C	Ward	Queen Elizabeth Hospital, Glasgow
M	Khan	Queens Medical Centre, Nottingham
K	Holzman	Redhill Hospital, Surrey
J	Ritchie	Rotherham Hospital
A	Hormis	Rotherham Hospital
J	Morgan	University Hospital of Wales, Cardiff
D	George	University Hospital of Wales, Cardiff
N	Hoskins	University Hospital of Wales, Cardiff
J	Fryer	University Hospital Southampton
R	Wright	University Hospital Southampton
L	Frost	University Hospital Southampton
P	Ellis	University Hospital Southampton
A	Mackay	University Hospital Wishaw, Scotland
K	Gray	Victoria Hospital, Kirkcaldy, Scotland
M	Jacobs	Watford General Hospital
I	Musliam Veettil Asif	West Middlesex university hospital
P	Amiri	West Middlesex university hospital
S	Shrivastava	West Middlesex university hospital
F	Raza	West Middlesex university hospital
S	Wilson	Wexham Park Hospital
M	Riyat	Wexham Park Hospital
H	Knott	Wexham Park Hospital
M	Ramazany	Whiston Hospital, Merseyside
S	Langston	Whiston Hospital, Merseyside
N	Abela	Whiston Hospital, Merseyside
L	Robinson	Whittington Hospital, London
D	Maasdorp	Whittington Hospital, London
H	Murphy	Whittington Hospital, London
H	Edmundson	Whittington Hospital, London
R	Das	Whittington Hospital, London
C	Orjioke	Whittington Hospital, London
D	Worley	Whittington Hospital, London
W	Collier	Whittington Hospital, London
J	Everson	Whittington Hospital, London
N	Maleki	Whittington Hospital, London
A	Stafford	Whittington Hospital, London
S	Gokani	Whittington Hospital, London
M	Charalambos	Whittington Hospital, London
A	Olajide	Whittington Hospital, London
C	Bi	Whittington Hospital, London
J	Ng	Whittington Hospital, London
S	Naeem	William Harvey Hospital, Kent
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S	Graham	Mater Misericordiae University Hospital, Ireland
S	Kukaswadia	Mercy University Hospital, Ireland
C	Prendergast	Midlands Regional Hospital Tullamore, Ireland
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